Flying the ILS

The thinking man's approach to the perfect approach

by BARRY SCHIFF / AOPA 110803

Localizer Needle Deflection	At the runway threshold	Distance from Runway Threshold					
		¼ nm	½ nm	¾ nm	1 nm	2 nm	3 nm
¼-Scale Deflection	88 ft	101 ft	114 ft	127 ft	141 ft	194 ft	247 ft
½-Scale Deflection	175 ft	202 ft	228 ft	255 ft	281 ft	387 ft	493 ft
¾-Scale Deflection	263 ft	302 ft	342 ft	382 ft	422 ft	581 ft	740 ft
Full Deflection	350 ft	403 ft	456 ft	509 ft	562 ft	775 ft	987 ft
Localizer Width	700 ft	806 ft	912 ft	1,018 ft	1,125 ft	1,549 ft	1,974 ft

To find the *distance of the aircraft from the center of the localizer*, enter table with amount of needle deflection and distance of aircraft from runway threshold. (Note: This table is based on a 4°-wide localizer.)

TABLE 1

■■ Believe it or not, there is quite a similarity between romancing and the ILS approach. Not only can each be performed with mechanical movements learned by rote, but experience teaches that—in both cases—the most successful are those who have learned to execute these procedures with finesse and a certain delicate touch.

Most ILS novitiates attempt to keep the cross pointers centered by applying techniques learned while chasing VOR needles on cross-country flights. Although the localizer and glideslope are similar in principle to VOR radials, they are considerably more sensitive and demand a refined mental attitude. The large corrections used during VOR navigation cannot be tolerated during an ILS approach.

To appreciate the sensitivity of a localizer needle, consider, for example, that a VOR radial has an effective width of 20°. In other words, a pilot must displace the aircraft 10° either side of a selected radial to cause the CDI (course-deviation indicator) to deflect fully.

The average localizer, on the other hand, has a width of only 4°. A displacement of only 2° from the centerline results in maximum CDI deflection. In other words, the localizer is five times as sensitive as a VOR radial at any given distance from the transmitter. (It is interesting to note that localizer course widths vary from 3° to 6°. Each is tailored so as to be 700 feet wide at the runway threshold. And since a localizer transmitter is usually just beyond the rollout end of its associated runway, it is obvious that short runways have relatively wide localizers and long runways relatively narrow ones.

An appreciation of localizer sensitivity combined with the suggestions that follow can considerably improve a pilot's ability to execute an ILS approach to minimums.

Table 1 demonstrates why localizer corrections must be so minimal. When tracking a 4°-wide localizer, for example, at a distance of only 1 nm from the runway threshold, the chart shows that when the needle is deflected one-quarter scale, the aircraft is only 141 feet from being precisely on course.

Unfortunately, to a pilot accustomed to VOR flying, a quarter-scale deflection seems like quite a bit. When between VORTAC stations, a return to course might require a 10° correction (or more) to be held for several minutes. This previous experience with the CDI has an adverse effect on the pilot because it creates the tendency to make similarly large corrections when tracking an ILS.

The same correction (10°) applied to a localizer when only 141 feet off course results in such a rapid return to the centerline that overshooting the localizer is almost impossible to avoid.

With respect to a localizer (and not a VOR radial), a quarter-scale deflection is not that big a deal. When 141 feet off course, the aircraft is only 41 feet (usually) from being lined up with the average, 200-foot-wide runway.

Putting this in proper perspective, consider how small a correction would be required when 141 feet from the extended runway centerline during a VFR, straight-in approach. Very little. The heading change would be barely noticeable. Quite obviously, the same minor correction should be made during an actual ILS approach.

This, then, is what is meant by the need to adopt the proper mental attitude. Heading changes during an ILS approach should only be a small fraction of what is normally required to center an equally-displaced needle when tracking a VOR radial.

Most pilots who have difficulty keeping the localizer needle within reasonable limits are usually guilty of chasing the needle. They have not learned that the secret of a successful ILS approach is the result of logical, minimal, predetermined heading changes.

For example, assume that a pilot is intercepting the localizer. He rolls out on the ILS heading just as the needle centers in the "bull's-eye." The published magnetic course of the ILS becomes what is called the temporary "reference heading" which, in this case, shall be 095°.

Under no-wind conditions and with an error-free directional gyro, this heading theoretically would lead the aircraft precisely along the localizer. Of course, such is rarely the case.

Expecting some drift, the pilot pays careful attention to needle behavior, while flying the reference with flawless determination. *He knows that an inadvertent heading change causes the LOC needle to move and leads to the false impression that wind drift is the responsible culprit.* An accurate "picture" of the wind cannot be drawn unless the reference heading is precisely maintained.

The heading is 095° and the needle slowly moves left. There are two possible reasons for this: a left crosswind or an improperly set directional gyro (or a combination of both). But this pilot is sharp. Once on the localizer, he knows that to subsequently reset the DG can only interfere with his plans to execute the perfect ILS approach. Once the DG has been synchronized with the compass, *prior to localizer intercept,* he will assume that *all needle movement* is caused either by *wind drift* or *heading change.*

As the needle moves left, the pilot rolls into a shallow-banked turn toward the needle. His immediate intention is not to center the needle, but simply to stop it dead in its tracks.

After 5° of turn, in this case, the needle stops and the pilot rolls the wings level. He precisely maintains the new heading (090°) and again begins his vigil of the vertical needle. If the needle remains in its displaced position, the pilot knows that this new heading (090°) is causing the aircraft to essentially "parallel" the localizer. He knows also that whatever heading "parallels" the localizer also can be used to track

	Distance from Runway Touchdown Zone					
Glideslope Needle Deflection	**¼ nm**	**½ nm**	**¾ nm**	**1 nm**	**1½ nm**	**2 nm**
¼-Scale Deflection	5 ft	9 ft	14 ft	19 ft	28 ft	37 ft
½-Scale Deflection	9 ft	19 ft	28 ft	37 ft	56 ft	74 ft
¾-Scale Deflection	14 ft	28 ft	42 ft	56 ft	84 ft	111 ft
Full Deflection	19 ft	37 ft	56 ft	74 ft	111 ft	149 ft
Glideslope Thickness	37 ft	74 ft	111 ft	149 ft	223 ft	297 ft

To find the *distance of the aircraft above or below the glideslope,* enter table with amount of needle deflection and distance of aircraft from runway touchdown zone (not runway threshold).

TABLE 2

	Glideslope Angle				
Ground Speed	**2°**	**2½°**	**3°**	**3½°**	**4°**
60 knots	212	265	319	372	425
70 knots	248	310	372	434	496
80 knots	283	354	425	496	567
90 knots	318	398	478	558	638
100 knots	354	442	531	620	709
110 knots	389	487	584	682	779
120 knots	425	531	637	744	850

To find the *recommended sink rate (fpm),* enter table with anticipated ground speed and glideslope angle (from approach plate).

TABLE 3

Landing in the Blind

One popular, hangar-flying topic involves the *emergency* ILS procedures that could be used to land—if absolutely necessary—during zero-zero conditions. It can be done, but requires a cool hand on the control wheel and a totally dispassionate mental attitude.

The approach should be executed with minimum (or no) flaps because this results in a relatively nose-high attitude (in most planes) and increases the likelihood of landing on the mains and not on the nosewheel.

Upon reaching the normal DH, the ILS needles must be steady; cross-tracking cannot be tolerated. As long as the localizer is kept to within a one-quarter scale deflection, the aircraft will land on the runway. Between DH and touchdown, a single correction of no more than one or two degrees should be considered. If more than this is required, execute a missed approach and try again.

At the normal DH, maintain the sink rate that had been successful in keeping the glideslope needle from moving immediately prior to DH. But at 100 feet agl, reduce the sink rate by ⅓ to ½ and ignore further glideslope indications. Trust that the reduced sink rate will prevent a premature touchdown.

Do not pay attention to the glideslope below 100 feet because (1) it becomes too sensitive for a manual approach (2) it flares out and stays between 18 and 27 feet above the runway.

Do not attempt to flare the aircraft; descend from 100 feet agl to touchdown at a constant sink rate. When the mains hit, chop the power and allow the nose to pitch down (to prevent a bounce). Use a modicum of nosewheel steering to keep the localizer in line and apply moderately heavy braking to prevent rolling off the far end of the runway.

This technique works and can be practiced under the hood with a sharp instructor in the right seat. If you can do this, shooting an ILS approach to conventional minimums is as easy as finding sand at the beach.

FLYING THE ILS continued

the localizer when the needle is centered later. This new heading (090°) becomes the revised "reference heading" and quite accurately compensates (within a degree or two) for any prevailing wind and/or any discrepancy between compass and DG.

If the needle continues to move, however, it is at a much reduced rate and the pilot can make whatever smaller correction is necessary to stop needle movement. The end result becomes the new "reference heading."

Since it is his desire to center the needle, the pilot turns farther left to a heading of 085°. Obligingly, the needle moves towards the bull's-eye. As the needle centers, does this pilot have to guess at what heading shall be required to track inbound? Of course not. He turns to the reference heading (090°) and smugly observes the captured localizer. He is now ready to intercept the glideslope and continue with this, the thinking man's approach.

This two-step maneuver of (1) turning to stop needle movement and then (2) turning farther to intercept the localizer can be accomplished by a savvy pilot in one smooth move. He turns toward the digressing needle and simply notes the "reference heading" at that point during the turn when the needle comes to a halt. But the turn continues briefly and without interruption to reverse needle movement. When the needle returns to the bull's eye, a turn is made to the "reference heading" noted during the initial turn.

As the descent begins, no one can be so naïve as to believe that wind drift will not change. We can count on it. The point is this: Unless a strong wind shift (or shear) exists between the ground and 1,500 feet agl, drift change will be gradual. As the localizer needle begins to react accordingly, a pilot must similarly turn to stop the needle and establish a new reference heading, one that can be used until conditions again require a change. The idea is to fly logical headings, based on observations of needle behavior, and not to take arbitrary, random swipes at the localizer.

As the aircraft descends on the glideslope, it also gets closer to the localizer transmitter which further increases needle sensitivity. Although the same techniques are used when the localizer moves off center, heading changes must be proportionately smaller. A 2° heading change near minimums, for example, has about the same effect on needle movement as a 6° "bite" when near the outer marker.

As the aircraft approaches the DH (decision height), it becomes increasingly more important to fly a specified heading and to not chase the needle. The most urgent requirement is that the needles not be in motion because this indicates cross-tracking and is usually more responsible for missed approaches than arriving at minimums with slightly offset, yet motionless needles.

If the localizer is slightly left or right (and motionless), it is better to accept being a few feet off course than to risk initiating a cross-track correction that could result in a larger needle displacement in the opposite direction. In other words, don't be so precise that a slight needle deflection cannot be tolerated (unless you can make exacting one- or two-degree turns or are below the glideslope). The obsession to exactly center the needles can blow an approach. (This applies, of course, to Category I approaches only; the lower minimums associated with Category II approaches do require substantially more precision *and* equipment.)

The glideslope is another breed of cat, similar to the localizer but even more sensitive. It has an effective width of only 1.4°. In other words, a vertical deviation of only seven-tenths of one degree fully deflects the horizontal indicator.

Table 2 graphically displays glideslope sensitivity. When 2 nm from the runway touchdown zone, for example, a needle deflected half-scale indicates that the aircraft is only 74 feet above or below the glideslope. When only one-half mile from the touchdown zone, the same needle deflection translates to only a 19-foot deviation from perfection.

To put it another way, the glideslope is 14 times as sensitive as a VOR needle and three times as sensitive as the localizer at equal distances from the station transmitters. Or consider this—when tracking a glideslope one mile from the touchdown zone, the needle has the same sensitivity as when tracking a VOR radial when only 7/100 nm from the VORTAC transmitter (if that's possible).

Such sensitivity requires thinking about the controls (or perhaps breathing on them) more than it does moving them. Tracking this ILS beam also requires the proper mental attitude.

Instead of requiring a "reference heading" (as does the localizer), the glideslope *demands* a reference sink rate. The VSI (vertical speed indicator) is often ignored, but is the magical key required to unlock the airport when ceiling and visibility conspire against you.

Prior to glideslope intercept, determine from the approach plate the recommended sink rate required to slide down the glideslope at the ground speed anticipated during the approach. Table 3 shows, for example, that a 4° glideslope (the steepest in the U.S. is actually 3.9°) requires a 709-fpm sink rate when ground speed is 100 knots.

Usually, however, you can predict the required sink rate without referring to any table. Since most glideslopes are on the order of 2¾° to 3°, this handy rule of thumb can be used: "Cut the approach ground speed (knots) in half and add a zero." When using a 3° glideslope with a ground speed of 80 knots, for example, sink rate should be approximately 400 fpm. Table 3 indicates a required sink rate of 425 fpm, but there aren't many pilots who can control a VSI quite that precisely.

As the glideslope is intercepted, immediately establish and attempt to maintain the recommended sink rate. If this is done correctly *and* if ground speed remains constant, the glideslope needle will require no further attention. But this happens only in textbooks; the glideslope undoubtedly will move off center.

Quite obviously, variations in sink rate are required to arrest a displaced glideslope needle, but it is the method and amount of correction that require emphasis.

What is about to be said is certain to raise eyebrows and attract scowls from the purists, but the best and easiest way to recapture a displaced glideslope needle is to simply apply the appropriate elevator pressure *without* regard to airspeed and power. Allow airspeed to vary (within reason) and to hell with power adjustments—why complicate the issue by trying to rub your tummy and the top of your head simultaneously. Simply nudge the yoke and adjust sink rate slightly. (Do, however, keep a ready hand on the throttle in case airspeed starts to get out of hand. Unless a wind shear is present, however, airspeed usually takes care of itself rather nicely.)

The required sink rate adjustment rarely exceeds 200 fpm. So, if a 500-fpm sink rate is being used and the glideslope needle begins to rise, change the sink rate to 300-fpm and watch needle behavior. Usually, it will return toward the bull's-eye at which time the original 500-fpm sink rate (or slightly less) should be resumed.

If the needle stops or only slows a little, then reduce sink rate an additional 100 fpm. Very little change in sink rate is usually all that's necessary to recapture the glideslope. Just tickle the yoke; don't horse around with it.

Unless the glideslope needle is fully deflected upwards, don't reduce the sink rate to zero. Such an abrupt change requires subsequent abruptness (and sloppy technique) to prevent the needle from dropping rapidly toward the bottom of the instrument.

Unless wind conditions change dramatically and unless an aircraft is dangerously below the glideslope, varying sink rate by more than 200 fpm is rarely necessary.

To appreciate the finesse required to do this properly, concentrate on varying sink rate by increments of 100 or 200 fpm during a visual, straight-in approach. Learn how little control movement is required. Observe also, during a visual approach, how little the elevator is used to remain "in the (visual) slot." It's no different when the aircraft is engulfed in cloud and the glideslope is being used for descent.

So you see, flying the cross-pointers is sort of like romance. Both require the proper mental attitude, a soft touch and the ability to put it all together (meaning the localizer, the glideslope and the instrument bull's-eye, of course). □